RV *Investigator* Voyage Plan

VOYAGE #:	IN2024_T01
Version Number:	FINAL
Voyage title:	Fremantle to Hobart, 2024 Transit
Mobilisation:	Fremantle, Thursday 7 March, 2024
Depart:	Fremantle, 0800 Saturday 9 March, 2024
Return:	Hobart, ~1300 Wednesday 20 March, 2024
Demobilisation:	Hobart, Thursday 21 March, 2024
Voyage Delivery Coordinator:	David Flynn
Voyage Manager:	Ben Arthur
Chief Scientist:	Jo Whittaker
Affiliation:	UTAS
Supplementary Project Principal Investigators:	1. Jo Whittaker: UTAS, 2. Elise Tuuri: Flinders Uni, 3. Peter Strutton: UTAS
Project name:	1. Australia's Southern Tectonic Margin: Understanding how Australia and Antarctica broke up. 2. Microplastics in the food chain: impact on planktonic organisms and understanding microplastic distributions. 3. Characterization of data quality from a 6000m CTD: the RBRargo³|deep6k in the Great Australian Bight.

Scientific objectives

Voyage objectives

The primary objective of voyage IN2024_T01 is the safe and timely transit of RV *Investigator* from Fremantle to Hobart in preparation for future voyages leaving the port of Hobart. Up to **88 hours** of operational time (weather dependent) within the transit voyage was allocated to conduct scientific operations for Supplementary Projects. Any remaining time would be available for Piggyback Projects, along with opportunistic seafloor mapping – while keeping "Expected Time of Arrival" in Hobart on track as the primary objective.

HSE Voyage Report

The MNF, in consultation with the science party and other relevant stakeholders, will develop a comprehensive HSE Voyage Report to ensure voyage risks are identified and appropriately controlled.

Media Activities

The MNF will seek to pursue opportunities that arise during the voyage to promote the science, scientists and ship, via conventional and social media channels, in consultation and/or collaboration with the relevant ship user.

Summary of the planned media activities for the voyage to ensure all voyage participants are aware of what may occur in this space. It should document activities for the sponsoring agency/participants and those to be undertaken for the MNF. If a media plan has been developed then this can be referenced and appended to the Voyage Plan.

ORGANISATION	ACTIVITIES	TIMING	RESPONSIBLE PERSON
UTAS	Olivia Dove (UTAS) will lead a range of media activities before, during, and after the voyage.	Throughout voyage	Olivia Dove working with Lucinda Ross

Activity plan for first 24-48 hours of voyage

Day	Date	Time	Activity
Saturday	9 March	0800	Sail from Port Fremantle WA at ~0800. Commence piloted transit through Cockburn Sound to North Eastern Rottnest Island
Saturday	9 March	1000	Disembark pilot. Commence ~4 hr transit via Rottnest Island
Saturday	9 March	1200	Begin transit South over West Australian shelf
Sunday	10 March	0000	Conduct shallow CTD and net casts, then continue transit via Traffic Separation Scheme
Monday	11 March	0600	Begin transit to deep CTD sites
Tuesday	12 March	1800	Arrive on location for first deep CTD site, ~8hrs deployment

Voyage track

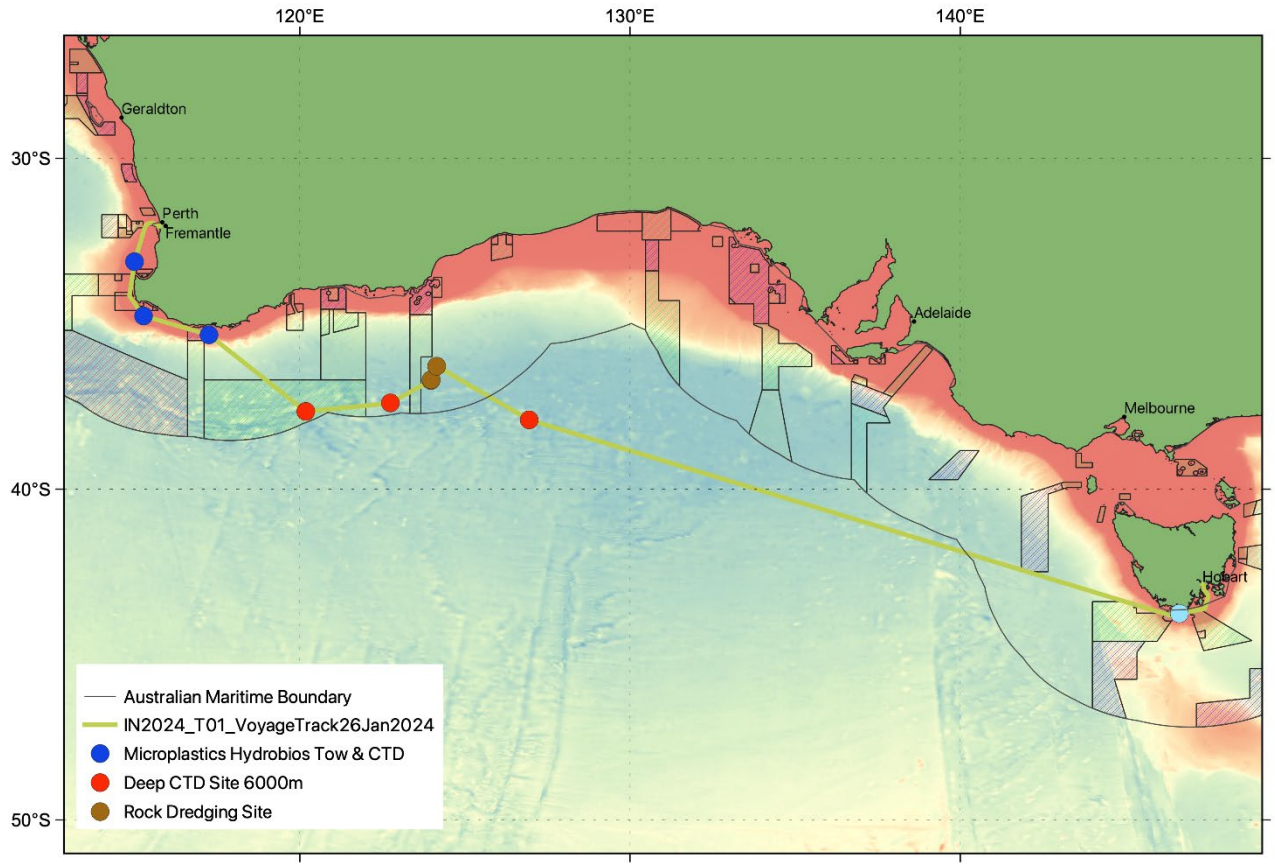


Figure 1. Voyage Track planned for IN2024_T01.

Waypoints, stations & time estimates

The following time estimates are based on a steaming speed of 10 knots, except for in and out of port which are at 5 knots.

Site	Lat	Long	Ops. Time (Hrs)	Cumulative Time (Hrs)	Cumulative Overall Time
Inner Harbour Berth	32° 02.886' S	115° 44.682' E	0	0	9/03/2024 8:00
Arthur Head	32° 03.241' S	115° 44.322' E	0	0.1	9/03/2024 8:05
Inner Harbour Entrance	32° 03.468' S	115° 42.227' E	0	0.5	9/03/2024 8:27
Inner Pilot Boarding Ground	32° 01.400' S	115° 41.300' E	0	0.9	9/03/2024 8:53
Land Fall Beacon	31° 57.488' S	115° 37.851' E	0	1.4	9/03/2024 9:23
Tuuri Planned #1	33° 21.132' S	114° 31.813' E	4	16.0	9/03/2024 23:58
Enter TSS	33° 58.976' S	114° 34.837' E	0	19.8	10/03/2024 3:46
TSS Mid	34° 30.971' S	114° 45.288' E	0	23.1	10/03/2024 7:05
Tuuri Planned #2	34° 45.854' S	115° 15.989' E	4	30.0	10/03/2024 14:01
Tuuri Planned #3	35° 20.224' S	117° 14.913' E	4	44.4	11/03/2024 4:21
Strutton Planned #1	37° 39.132' S	120° 10.770' E	8	72.2	12/03/2024 8:11
Strutton Planned #2	37° 23.582' S	122° 44.506' E	8	92.5	13/03/2024 4:29
Whittaker Planned #1	36° 42.961' S	123° 58.266' E	11	110.6	13/03/2024 22:38
Whittaker Planned #2	36° 41.580' S	123° 58.686' E	11	121.8	14/03/2024 9:47
Whittaker Planned #3	36° 17.039' S	124° 08.580' E	11	135.4	14/03/2024 23:22
Strutton planned #3	37° 54.488' S	126° 56.698' E	8	160.0	15/03/2024 23:57
Tuuri reserve #1	43° 40.577' S	145° 54.033' E	0	252.6	19/03/2024 20:33
Mewstone	43° 48.620' S	146° 20.195' E	0	254.6	19/03/2024 22:36
South Bruny	43° 32.832' S	147° 25.307' E	0	259.6	20/03/2024 3:34
GSM Backscatter Cal. #2 End	43° 30.632' S	147° 26.618' E	0	259.8	20/03/2024 3:48
GSM Backscatter Cal. #2 Start	43° 24.478' S	147° 27.939' E	0	260.4	20/03/2024 4:26
Storm Bay	43° 09.149' S	147° 31.376' E	0	262.0	20/03/2024 5:59

Iron Pot	43° 03.687' S	147° 23.440' E	0	262.8	20/03/2024 6:47
White Rock	42° 58.582' S	147° 22.499' E	0	263.3	20/03/2024 7:18
Hobart PBG	42° 55.411' S	147° 22.972' E	0	263.6	20/03/2024 7:37
Garrow	42° 54.872' S	147° 22.972' E	0	263.7	20/03/2024 7:40
Battery Pt	42° 53.027' S	147° 20.701' E	0	263.9	20/03/2024 7:55
Sullivans Cove	42° 53.026' S	147° 20.356' E	0	264.0	20/03/2024 7:58
Hobart PW4 (CSIRO, TAS)	42° 53.170' S	147° 20.320' E	0	264.0	20/03/2024 8:00
Total Ops Time (Hrs, Days), Scheduled Return Date and Time			**69.0**	**11.0**	**20/3/2024 8:00**

Reserve (Off Track) Sites

Jutzeler #1	36° 17.040' S	124° 08.580' E
Jutzeler #2	38° 05.972' S	127° 43.017' E
Jutzeler #12	37° 54.488' S	126° 56.698' E
Jutzeler #15	43° 39.426' S	139° 24.915' E
Jutzeler #16	44° 21.971' S	141° 22.600' E
Jutzeler #17	44° 15.699' S	142° 14.806' E
Jutzeler #20	44° 00.942' S	144° 10.636' E
Jutzeler #21	43° 56.163' S	144° 22.122' E
Jutzeler #22	43° 56.647' S	144° 34.617' E
Jutzeler #23	44° 08.432' S	145° 02.742' E
Jutzeler #24	44° 03.751' S	145° 12.778' E
Jutzeler #25	44° 01.903' S	145° 28.314' E

CTD Configuration, plan & water budget

The science party may be required to assist with sampling the Niskin bottles, preparing the bottles for deployment and for setting up and logging each deployment of the CTD. Training will be given by the MNF DAP and hydrochemistry teams on board.

Plan for the following maximum rate of analyses based on 2 Hydrochemists:

- 48 nutrients, 48 dissolved oxygen, 48 salinity analyses per 24 hours; OR
- 72 nutrient, 36 dissolved oxygen, 36 salinity analyses per 24 hours; OR
- 160 nutrient analyses (only) per 24 hours.

	PLEASE SELECT:
Fundamentals:	
Which CTD rosette to be used for this voyage (24 or 36 Niskin bottles):	36
Likely total number of casts:	4
Likely maximum depth of deepest cast:	>6000 m
Standard CTD Configuration - Instrumentation (All 8 auxiliary channels Used) 6000 m 1 x SBE9+ (CTD) 2 x SBE3P Temperature Sensors 2 x SBE4C Conductivity Sensors 2 x SBE5T pumps	
2 x SBE43 Dissolved Oxygen Sensors 1 x Tritech PA500 Altimeter 1 x Biospherical QCP2300HP PAR Sensor 1 x Wetlabs C-Star 25cm Transmissometer 1 x Wetlabs ECO FLCDRTD Fluorometer – CDOM (370/460nm) 1 x Wetlabs ECO FLBBRTD Fluorometer – Chlorophyll-a & Back Scatter (2 x Channels)	
Alternative Instruments (Can be substituted from standard configuration):	
Seapoint Turbidity Meter – Nephelometer:	
Chelsea Aquatracka III (430/685nm) Fluorometer – Chlorophyll-a:	
Seabird SUNA – Ultraviolet Nitrate Analyzer (**Serial Connection - 2000 m**):	
Standard LADCP Configuration – Instrumentation: 6000 m 1 x Teledyne 300 kHz LADCP (Slave - Up) 1 x Teledyne 150 kHz LADCP (Master - Down) 1 x 48V Deep Sea Battery	
Alternative LADCP Configuration - Instrumentation: 6000 m 1 x Teledyne 300 kHz LADCP (Slave - Up) 1 x Teledyne 300 kHz LADCP (Master - Down) 1 x 48V Deep SeaBattery	
Hydrochemistry Analyses:	
Salinity	X
Dissolved Oxygen	X
Nutrients: Nitrate	X
Nutrients: Phosphate	X

	PLEASE SELECT:
Nutrients: Silicate	X
Nutrients: Nitrite	X
Nutrients: Ammonia	X

Please note any special requests – such as special sampling that is intended to be performed by the science party (e.g. sampling for dissolved gases, radioisotopes, etc.); or any user-supplied instrumentation to be fitted to the CTD frame; etc.

Supplementary projects

1. Jo Whittaker: Australia's Southern Tectonic Margin: Understanding how Australia and Antarctica broke up. Ship Time: 33 hrs (originally allocated 40 hrs)

Proposed work: Two (2) priority dredges are planned, with the possibility of an additional site if time permits, see locations below. Targets are basement ridges shown to rise above the surrounding sediment in existing seismic reflection profiles. We hope to recover basalt, gabbro, serpentinised peridotite, and/or other continental mantle or possibly continental crustal rocks.

Seismic reflection data but not swath bathymetry exists for all proposed locations. Need to acquire swath bathymetry prior to dredge deployment to refine target location.

Swath map = 3 hours each.
Deploy / recover rock dredge to max 5000m at 60m/min wire in/out = 3 hours each way
Cable on the bottom = 3 hour
Sorting rocks on back deck = 1 hour
General setting up = 1 hour
Total 11 hours per dredge.
3 dredges = 33 hours.

All activities will be executed within the Australian EEZ and outside of Australian Commonwealth, State or Territory protected waters.

Planned sites

Site	Long	Lat	ChronOld	ChronYoung	Priority
1	123.971	-36.716	34y	33o	1
2	123.978	-36.693	34y	33o	1
3	124.143	-36.284	QZB	34y	1
Other potential sites					
4	123.828	-37.102	32	31	2
5	123.921	-36.834	32n	32n1	2
6	124.133	-36.312	QZB	34y	2
7	124.179	-36.173	QZB	34y	2
8	124.267	-35.923	QZB	34y	2
9	124.276	-35.895	QZB	34y	2
10	127.46	-35.85	QZB	34y	3
11	127.29	-36.69	32	31	2
12	130.22	-37.84	32	31	1
13	130.24	-37.78	32	31	2

2. Elise Tuuri: Microplastics in the food chain: impact on planktonic organisms and understanding microplastic distributions. Ship Time: 12 hrs (originally allocated 12 hrs)

Proposed work: Along the existing voyage track, ideally on continental shelf, conduct 2x paired CTD and Hydrobios horizontal net tows for microplastics sampling. There are three planned sites and one reserve site at locations outline below:

Site	Long	Lat	Priority
Planned sites			
1	114.991	-33.126	1
2	115.265	-34.771	1
3	117.249	-35.334	1
Reserve site			
4	146.337	-43.810	2

Each CTD requires 3 Niskin bottles fired at each of: 20m from bottom, Deep Chlorophyll Max (DCM) and Sub-Surface, (9 bottles total). Each Hydrobios deployment, fitted with 335-micron nets, requires 2 nets activated at the same 3 depths: 20m from bottom (or max depth of HB net if seafloor is > 500 m deep), at DCM and Sub-Surface. Required sampling for each site and approximations of time below:

Sampling Method	Sampling Depths	Sample Type	Sampling time (approx)
CTD Deployment to bottom and determination of DCM			Depth Dependant
Niskin	20 m above max depth	3 x bottles	
Niskin	DCM	3 x bottles	
Niskin	Sub-surface	3 x bottles	
CTD/Niskin			**~ 1.5 - 2 hours**
HB Net deployment to max depth			Depth Dependant
Net #1	20 m above max depth	Microplastics	10 min @ ~ 2 knots
Net #2	20 m above max depth	Zooplankton	10 min @ ~ 2 knots
Transition net #3			Depth Dependant
Net #4	DCM	Microplastics	10 min @ ~ 2 knots

Net #5	DCM	Zooplankton	10 min @ ~ 2 knots
Transition net #6			< 5 min
Net #7	Sub-surface	Microplastics	10 min @ ~ 2 knots
Net #8	Sub-surface	Zooplankton	10 min @ ~ 2 knots
Retrieval net #6			< 5 min
HydroBios Nets			**~ 2 - 2.5 hours**
TOTAL			**~4 hours**

Therefore the water budget from the shallow CTD casts for the microplastics project are as follows:

- 3 x Niskin bottles from ~ 20m from bottom
- 3 x Niskin bottles from Deep Chlorophyll Max
- 3 x Niskin bottles from Sub-surface
    - Desirable: salinity and DO

Niskin bottle samples will be transferred to the lab in 10 L Nalgene bottles and vacuum filtered onto 0.45 um membranes. These will be stored at room temperature until analysis back in the laboratory at Flinders University. Cod ends/contents from each net (#2, #5 and #8, one from each sampling depth) will be preserved in 95% ethanol within 15 minutes of the end of the tow to study zooplankton community compositions at each site. Cod ends/contents from each other net (#1, #4 and #7) will be chemically digested in the fume hood using sodium dodecyl sulfate and hydrogen peroxide. The product of this digestion will be vacuum filtered onto 0.45 um membranes. Controls will also be collected where possible, such as samples of fibres from the clothes of the crew handling the CTD and net deployments, fibres from the HB net, paint flake samples from the frame of the net and the vessel, water samples processed through the Niskin bottles and atmospheric microplastics in the laboratory.

Throughout the voyage and particularly at the sampling sites, we will be assessing and analysing the physical process present at the time of and around sampling. The team will be utilising the 150 kHz ADCP and visual clues (i.e. floating detritus), to identify surface signatures of convergence zones (Langmuir Cells or Lagrangian Coherent Structures).

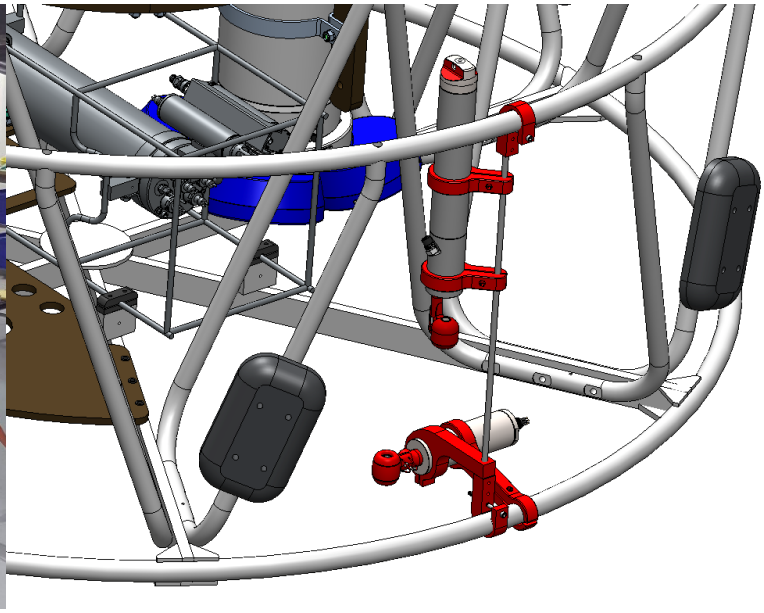
Equipment requested from the MNF: CTD with Niskin Bottle Rosette, Hydra-Bios net with either 100 um or 335 um net; Bongo nets as contingency; 2 x dissecting microscope; Laminar flow hood; Fume Hood; Milli-Q water; access to chemical storage.

3. Peter Strutton: Characterization of data quality from a 6000m CTD: the RBR*argo*|deep6k in the Great Australian Bight. Ship Time: 24 hrs (originally allocated 36 hrs).

Proposed work: CTD profiles in waters deeper than 6000m, at 3 different locations depending on weather and ship track, comparing onboard SeaBird 911 sensors to 10x user supplied RBR*argo*|deep6k CTDs, casts

expected to take 6 hours each. Additional BGC sensors will be mounted for characterization against sensors provided by MNF (see table above): the RBR*tridente* and RBR*coda* T.ODO will be mounted directly on the RBR*argo*|deep6k CTDs and therefore do not require any additional power, logging, or space.

Exact locations for sampling are flexible to fit within the existing voyage track. Plan for physical mounting of RBRargo units to CTD rosette:



Site locations (all >6,000m based on GEBCO 2022):

Deep CTD planned Site 1: 120° 10.770 -37° 39.132
Deep CTD planned Site 2: 122° 44.506 -37° 23.582
Deep CTD planned Site 3: 126.945 -37.912

Each profile will include:

> A soaking time, to ensure the SBE9 is working properly and all sensors are equilibrated thermally (10 min)
> A downcast completed at a maximum speed of 1 dbar/s.
> An upcast completed at a maximum speed of 1 dbar/s. During the upcast, approximately 21 bottles stops will be done (exact number of bottle samples depends on water budget). At each stop, the rosette will be held stationary for 5 minutes, then a water sample will be collected to be later analysed on a salinometer. Bottle stops depths will be selected depending on the downcast profile shape but nominally every 500m between 6000 and 1000m, every 100m between 1000m and 100m, and every 20m above 100m.

Once the rosette is on board, 42 water samples (250 mL each) will be collected (two from each bottle) to be analysed for salinity using a salinometer. Additionally, Oxygen samples will be collected and analyyzed on board at the same vertical resolution. Chlorophyll samples will also be collected to groundtruth fluorometers.

Piggyback projects

1. Minderoo eDNA 'OceanOmics' Sample Collections and Methods Comparison – Eric Raes & Marcelle Ayad

Proposed Work: Seawater from the underway sampling lab and from within the water budget of the existing CTD casts is planned to be processed through eDNA sampling devices, to compare outputs from

different processing equipment and methods. This work ties in with the Partnership between Parks Australia (Director National Parks) and Minderoo Foundation under the Ocean Discovery and Restoration Program, which aims to accelerate the use of genomic science and provide a 'proof of concept' that eDNA can be a cost-effective way to monitor biodiversity in Australia's large and remote marine parks, as compared to other marine sampling techniques. No ship time and 1-2 berths has been assigned to this project.

Water Budget from CTD casts:

- 1 Niskin at the same depths where microplastics will be collected;
- 1 Niskin at the depths where hydrochemistry will collect samples;
- three Niskins at the deepest depth (6000m).

2. Atmospheric Sampling & BoM Equipment – Alain Protat, Ruhi Humpries & Marc Mallet

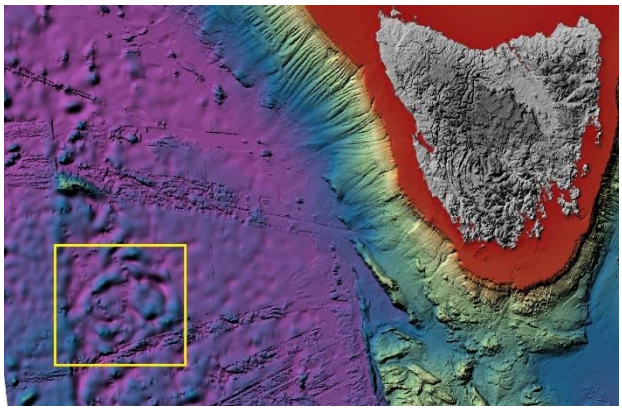
Proposed Work: Limited atmospheric sampling equipment from IMAS & Bureau of Meteorology will remain onboard following IN2024_V01 (further limited sub-sample of equipment to continue operationally during transit). No ship time or berths assigned to this project, some in-kind support from SIT to monitor equipment e.g. SIT will ensure the Stabilised Platform Container air conditioning is operational during the transit.

3. ARGO 'SOCCOM' Floats – Christina Schallenberg

Proposed Work: Deploy up to 3x 'SOCCOM' style ARGO floats during the transit between Fremantle and Hobart if time is available onboard. No ship time or berths assigned to this project, opportunistic deployments while at deep CTD stations on transit.

4. Opportunistic Mapping – Martin Jutzeler

Proposed Work: Waypoints of voyage track have been optimised to collect underway bathymetry en route to Hobart in South-West Tasmania. No ship time or berths assigned to this project, opportunistic mapping for the provided waypoints if time is available.



5. Strategic Partnership NOAA/GA/CSIRO – Amy Nau

Proposed Work: A berth for an experienced NOAA surveyor/technician to join RV Investigator and share knowledge with the GSM team and assist with mapping responsibilities.

6. Ship Works and Rotor Lift Helicopter Winching Drill

1) On the morning of last day of voyage, returning to Hobart in Storm Bay, Rotor Lift will work with the crew to perform a live drill of helicopter winching operations under Marine Order 57/ICS. All non-involved personnel will be asked to remain inside during these operations. The coordination of this work is expected to take the morning of the last day upon returning to Hobart waters, once complete coming alongside at Princes Wharf 04 at ~midday or shortly thereafter.
2) As contingency in case this work cannot be completed prior to this voyage, the crew will piggyback into a science deep CTD (~6000m) or perform a dedicated maintenance cast, to correct spooling on the outboard CTD winch. If piggybacking, the plan would be to separate science and maintenance tasks using the following plan:
    a. Complete planned downcast to ~6,000m, retaining intact data trace and not firing bottles
    b. Return up to depth of buried wire lay and correct spooling, adding ~1-2hrs of time to the cast,
    c. Pay out down to planned bottom depth and soak bottles/sensors, returning up and firing bottles as planned on the water budget.

Westpac helicopter approaching RVI (Picture: Rotorlift)

"Anyone order Uber Eats?" (Picture: Stef Stimson)

Permits

No operations are planned, except for approved underway science deployments/systems as per the following permits. An assessment of unplanned deployments (e.g. XBTs) is to be carried out onboard before commencing any operations.

- South West Marine Parks: PA2020-00041-2 (variation PA2020-00041-8)
- South East Marine Parks: PA2020-00041-1 (variation PA2020-00041-7)

Both permits preclude echosounders or other activities that may take, keep, move or interfere with a cetacean. Must act consistently with Part 8 of EPBC Regs 2000 for cetacean and whale watching approach distances and precautionary zones. Must not travel greater than 10 knots when cetaceans are likely to be present.

This voyage may or expects to traverse through the following Marine Parks:

- Perth Canyon Marine Park
- South West Corner Marine Park

- Eastern Recherche Marine Park
- Great Australian Bight Marine Park
- Western Eyre Marine Park
- Murray Marine Park
- Nelson Marine Park
- Zeehan Marine Park
- Tasman Fracture Marine Park
- Huon Marine Park

Signature

Your name	Jo Whittaker
Title	Chief Scientist
Signature	
Date:	27/02/2024